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**Forest Pest
Management**

Davis, CA.

FSCBG COMPUTER MODEL PREDICTIONS OF SWATH WIDTHS - 1988 WESTERN SPRUCE BUDWORM PROJECT PACIFIC NORTHWEST REGION

September 1989
3400-Forest Pest Management
FPM 89-4

Pesticide Precautionary Statement

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key--out of the reach of children and animals--and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary landfill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State extension specialist to be sure the intended use is still registered.

The use of trade, firm, or corporation names is for information and convenience of the reader. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement, or approval of any product or service to the exclusion of others which may be suitable.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife - if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

FPM 89-4

FSCBG COMPUTER MODEL PREDICTIONS OF SWATH WIDTHS - 1988 WESTERN SPRUCE BUDWORM PROJECT PACIFIC NORTHWEST REGION

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PREFACE

This report shows predicted swath widths for two fixed-wing and five rotary-wing aircraft using the Forest Service Cramer-Barry-Grim (FSCBG) computer model. It is intended that this report be used as a guide to assist the user in determining the widest swath width consistent with established criteria (e.g., 20 drops per square centimeter).

The report provides a reference for persons planning to apply the insecticide Bacillus thuringiensis (B.t.) to control western defoliators. Swath widths have been established based upon tradition, individual opinions, and conjecture. The USDA Forest Service (FS) and its cooperators now have two computer-based models that predict the swath width of an aircraft/spray system. These models, referred to as AGDISP and FSCBG, use technology described by Alan Bilanin (Bilanin et al., 1989). Swath width predictions can be determined quickly, economically, and the variables controlled with the models, in contrast to uncontrolled variables associated with field determinations.

Establishing the proper swath width is important to achieve economical application and effective control. Swath widths that are too wide might equate to more profit to the applicator or less cost to the FS, but less control; while swath widths that are too narrow might increase application costs but not necessarily increase control. We believe that attention to swath widths in recent years has been one of several factors that has contributed to improving application success.

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INTRODUCTION

FSCBG (Forest Service Cramer-Barry-Grim) is a scientific computer program (Curbishley and Skyler 1989) that provides a framework for describing the fate of spray from the time the material is released from an aircraft until it impacts on the target, or drifts to distances where deposition is no longer detectable. Inputs to the model include drop size spectrum, aircraft parameters, meteorology, and forest characteristics. The drop size distribution of the spray material is divided into discrete drop size categories represented by dispersion, evaporation, and canopy penetration algorithms. The contributions of various drop size categories are summed to provide deposition, dosage, or concentration estimates. The distribution of spray material about a mean cloud axis is assumed to be Gaussian. The model contains sub-routines for aircraft wake, droplet evaporation, and canopy penetration. It is capable of predicting deposition on open ground (as described herein), deposition at specified levels in a canopy, and downwind drift (both downwind deposit and air concentration).

Currently the FS is cooperating with Oregon State University and Continuum Dynamics, Inc. in conducting FSCBG user training. The model is operable on personal computers and operates efficiently on the 80386 with a math co-processor. Plans call for installing the model on the FS Data General system this year.

METHOD

A total of 18 FSCBG model runs were made using seven aircraft and four undiluted tank mixes of Bacillus thuringiensis (B.t.). The purpose of the model runs was to predict swath widths for each aircraft using the same atomizer configuration, tank mix, and application rate used in the Pacific Northwest Region (Region 6) 1988 western spruce budworm pre-project characterization trials. These characterization trials were conducted a few days before the operational project to calibrate, check atomization, establish swath widths, and check equipment operation. Table 1 shows the various aircraft and B.t. tank mix combinations used in the FSCBG model runs.

Model input data for aircraft specifications were obtained from Hardy (1987). Drop spectrum data were obtained from wind tunnel tests sponsored by the FS, and conducted and reported by the Department of Agricultural Engineering, University of California, Davis, CA (Yates et al., 1984; Yates and Cowden 1985; and Yates and Cowden 1986). All tank mixes were applied undiluted. The Thuricide 32LV, Thuricide 48LV, and Dipel 6AF (all water base tank mixes) were subject to an evaporation rate of 45%, 45%, and 50% respectively. The Dipel 6L (an oil base tank mix) was assumed to be non-evaporated. Nozzle configuration, speed of the aircraft, and application rate were taken from the Region 6, 1988 western spruce budworm characterization trial data sheets.

Table 1 - Aircraft and tank mix combinations.

Aircraft	Tank Mix[1.]
1. Turbo Thrush	Dipel 6L
2. Turbo Ag Cat	Dipel 6L
3. Bell 205A-1	Dipel 6L and Thuricide 32LV
4. UH-1	Dipel 6L
5. Hiller 12E Soloy	Dipel 6AF and Thuricide 48LV
6. Bell 212	Thuricide 32LV
7. Lama	Thuricide 32LV

1. Dipel is a trade name of Abbott Laboratories and Thuricide is a trade name of Sandoz Crop Protection Corporation.

The following input parameters were kept constant for all model runs:

1. Flight direction (each aircraft was flown a single swath in a south to north direction and in-wind)
2. Atomizer (Beecomist)
3. Air temperature (40 degrees Fahrenheit)
4. Humidity (80 percent)
5. Wind speed (2 1/2 miles per hour)
6. Wind direction (from 001 degree north)
7. Release height (50 feet above the ground)

RESULTS AND DISCUSSION

Swath widths as predicted by the FSCBG model are shown in Table 2. Swath widths were determined using threshold criteria of 20 and 25 drops per square centimeter. Graphs showing a summary of deposition for each model run are included in the Appendix (Figures 1-18). For ease of comparison the graph scale dimensions (drops per square centimeter and distance in meters) have been set up the same for all model runs in a particular aircraft/tank mix category.

Swath widths for all aircraft/tank mixes do not appear to be significantly different between the deposit thresholds of 20 and 25 drops per square centimeters. The widest swath widths are those with Thuricide 32LV applied at 64 ounces per acre, and the narrowest swath widths are those with Dipel 6AF applied at 43 ounces per acre. On the basis of aircraft type the widest swath widths were observed with the Bell 212 and Bell 205A-1 applying 64 ounces per acre. Therefore, based upon FSCBG model predictions and the limited number of model runs, wider swath widths should be expected from aircraft applying 64 ounces per acre. There was no attempt to conduct a statistical analyses of these data.

Operationally on the R-6 project swath widths were assigned to each aircraft as follows:

Turbo Thrush	150 feet
Turbo Ag Cat	150 feet
Bell 205A-1	180 feet
UH-1	150 feet
Hiller 12E	100 feet
Bell 212	180 feet
Lama	120 feet

These operational swath widths appear to be reasonable based upon the FSCBG predictions reported herein.

Table 2 - Predicted aircraft swath widths.

1. **Turbo Thrush @ 135 mph**
   Dipel 6L, 43 oz/acre
   8 Beecomist

Nozzle Configuration	Predicted Swath Width 20 drops/CM2	Predicted Swath Width 25 drops/CM2
77% of Wingspan (Figure 1)	130 feet	117 feet

2. **Turbo Ag Cat @ 130 mph**
   Dipel 6L, 43 oz/acre
   8 Beecomist

Nozzle Configuration		
75% of wingspan (Figure 2)	122 feet	112 feet

3. **Bell 205A-1 @ 90 mph**
   Dipel 6L, 43 oz/acre
   8 Beecomist

Nozzle Configuration		
72% of rotor (Figure 3)	165 feet	154 feet
71% of rotor (Figure 4)	165 feet	154 feet

4. **UH-1 @ 80 mph**
   Dipel 6L, 43 oz/acre
   8 Beecomist

Nozzle Configuration		
74% of rotor (Figure 5)	148 feet	136 feet[1].
70% of rotor (Figure 6)	145 feet	133 feet[1].

1. Figures 5 and 6 show a lower deposition directly beneath the aircraft that could be corrected by moving the two inside nozzles.

Table 2 - Predicted aircraft swath widths (continued).

5. **Hiller 12E Soloy @ 50 mph**
   Dipel 6AF, 43 oz/acre
   6 Beecomist

Nozzle Configuration	Predicted Swath Width 20 drops/CM2	Predicted Swath Width 25 drops/CM2
54% of rotor (Figure 7)	107 feet	95 feet
50% of rotor (Figure 8)	106 feet	92 feet

6. **Hiller 12E Soloy @ 50 mph**
   Thuricide 48LV, 43 oz/acre
   6 Beecomist

Nozzle Configuration		
54% of rotor (Figure 9)	193 feet	180 feet
50% of rotor (Figure 10)	189 feet	179 feet

7. **Bell 212 @ 90 mph**
   Thuricide 32LV, 64 oz/acre
   8 Beecomist

Nozzle Configuration		
69% of rotor (Figure 11)	233 feet	222 feet
63% of rotor (Figure 12)	260 feet	248 feet
56% of rotor (Figure 13)	249 feet	236 feet

8. **Bell 205A-1 @ 90 mph**
   Thuricide 32LV, 64 oz/acre
   8 Beecomist

Nozzle Configuration		
72% of rotor (Figure 14)	251 feet	237 feet
63% of rotor (Figure 15)	256 feet	241 feet

9. **Lama @ 70 mph**
   Thuricide 32LV, 64 oz/acre
   6 Beecomist

Nozzle Configuration		
67% of rotor (Figure 16)	198 feet	186 feet

Table 2 - Predicted aircraft swath widths (continued).

10. **Lama @ 70 mph**
Thuricide 32LV, 64 oz/acre
4 Beecomist

Nozzle Configuration	Predicted Swath Width 20 drops/CM2	Predicted Swath Width 25 drops/CM2
71% of rotor (Figure 17)	222 feet	211 feet
62% of rotor (Figure 18)	215 feet	204 feet

SUMMARY

The FSCBG aerial spray model was used to predict aircraft swath widths using operational information as input to the model. Model runs were made for seven types of spray aircraft and four different B.t. tank mixes. Swath widths using a deposit threshold of 20 drops per square centimeter ranged from 106 to 260 feet; and swath widths using a deposit threshold of 25 drops per square centimeter ranged from 92 to 248 feet. The widest swath width predictions were associated with the Bell 212 and Bell 205A-1 applying Thuricide 32LV with Beecomist atomizers at an application rate of 64 ounces per acre.

The FSCBG model provides an appropriate and economical alternative to conducting actual field tests to determine swath widths.

REFERENCES

1. Bilanin, Alan J., Milton E. Teske, John W. Barry, and Robert B. Ekblad. 1989. AGDISP: The aircraft spray dispersion model, code development and experimental validation. Transactions of the ASAE 32(1):327-334.

2. Hardy, Charles E. 1987. Aerial application equipment. USDA Forest Service, Equipment Development Center, Missoula, MT.

3. Curbishley, Thomas B. and Patricia J. Skyler. 1989. Revision 1 to User Manual - Forest Service aerial spray computer model - FSCBG (PC). A Program WIND Report, FPM 89-1. USDA Forest Service, Davis, CA.

4. Yates, W. E., R. E. Cowden, and N. B. Akesson. 1984. Drop size spectra for application of Thuricide 32LV with a Beecomist atomizer. FPM 84-3. USDA Forest Service, Davis, CA.

5. Yates, W. E. and R. E. Cowden. 1985. Drop size spectra of rotary atomizers with Bacillus thuringiensis tankmixes. FPM 86-1. USDA Forest Service, Davis, CA.

6. Yates, W. E. and R. E. Cowden. 1986. Drop size spectra for Beecomist, Micronair, and an 8006 flat fan nozzle with Dipel 8L and Thuricide 48LV. FPM 86-4. USDA Forest Service, Davis, CA.

APPENDIX

FSCBG Graphs - Figures 1-18

Figure 1 - Turbo Thrush, 8 Beecomist Atomizers, 77% of Wingspan, Dipel 6L Undiluted @ 43 oz/ac.

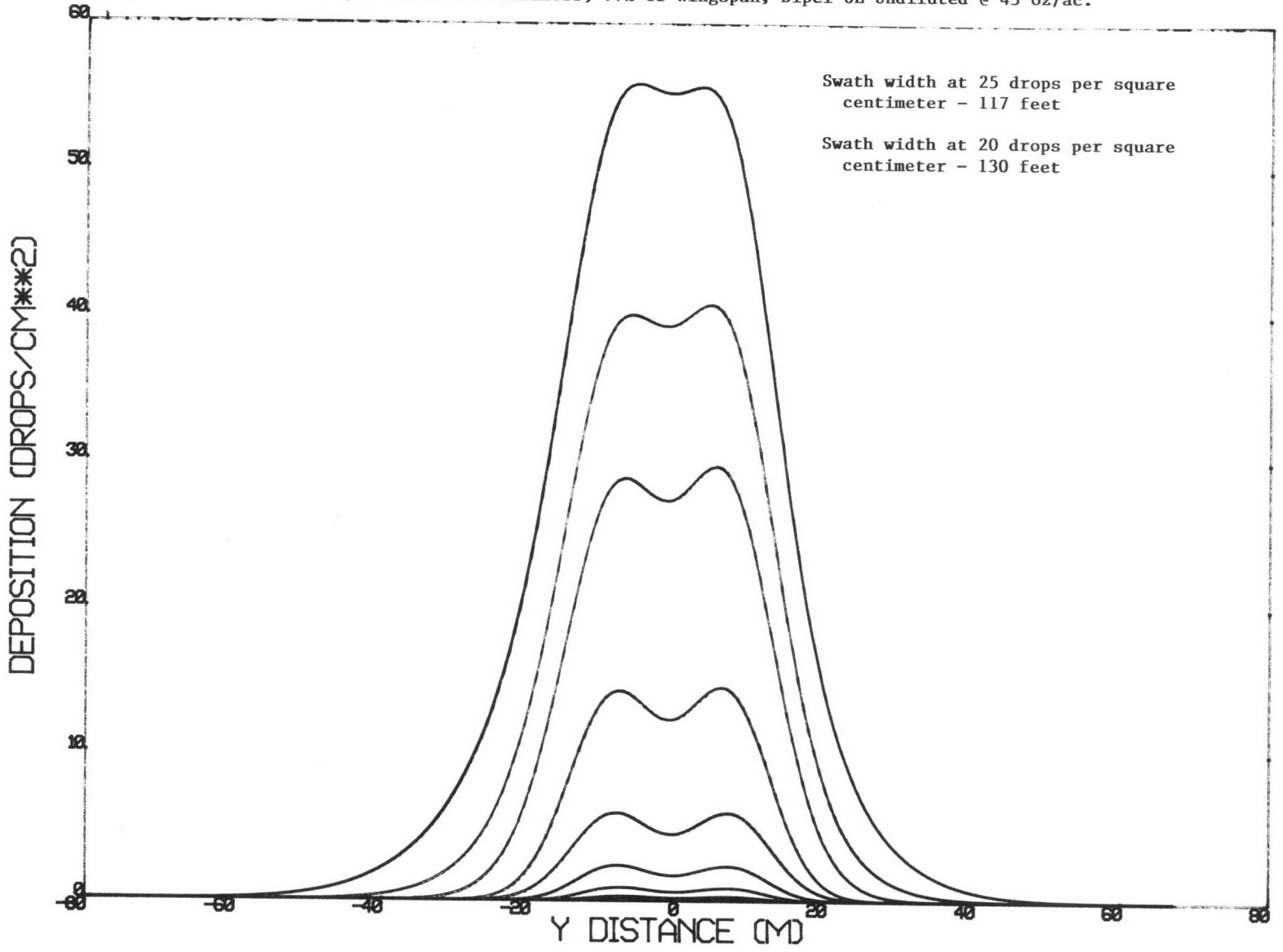

Figure 2 - Turbo Ag Cat, 8 Beecomist Atomizers, 75% of Wingspan, Dipel 6L Undiluted @ 43 oz/ac.

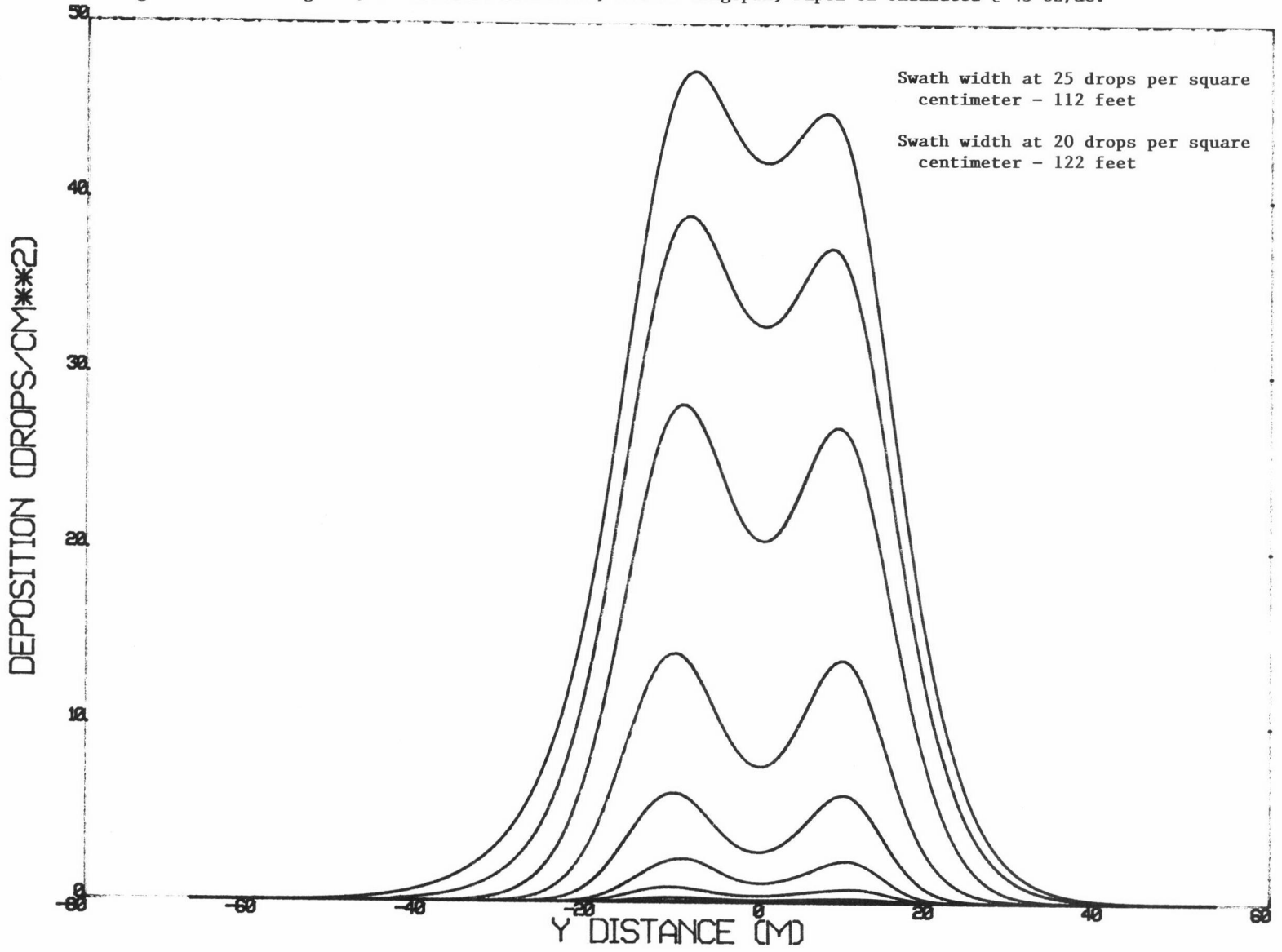

Figure 3 - Bell 205A-1, 8 Beecomist Atomizers, 72% of Rotor Diameter, Dipel 6L Undiluted @ 43 oz/ac.

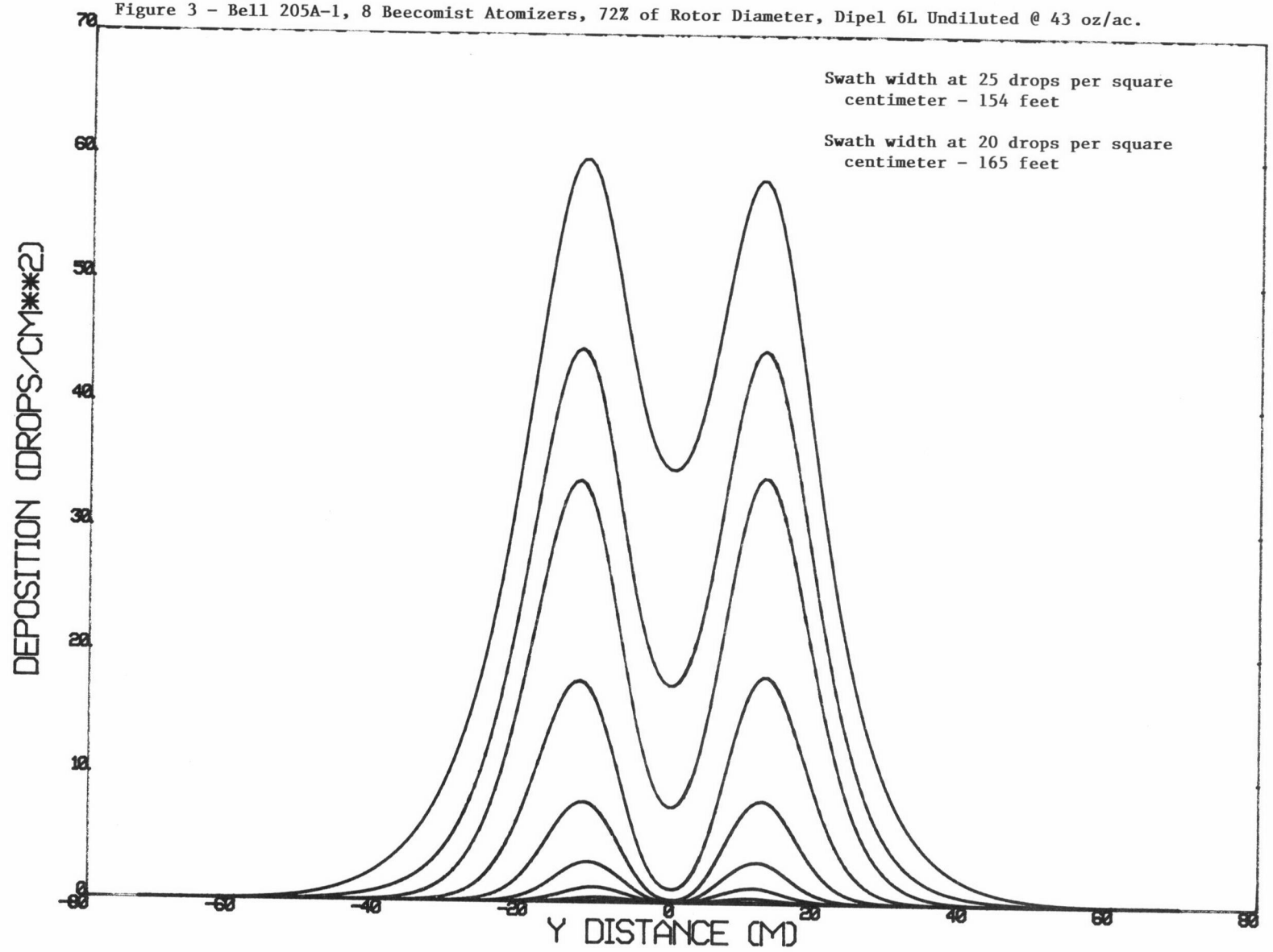

Figure 4 - Bell 205A-1, 8 Beecomist Atomizers, 71% of Rotor Diameter, Dipel 6L Undiluted @ 43 oz/ac.

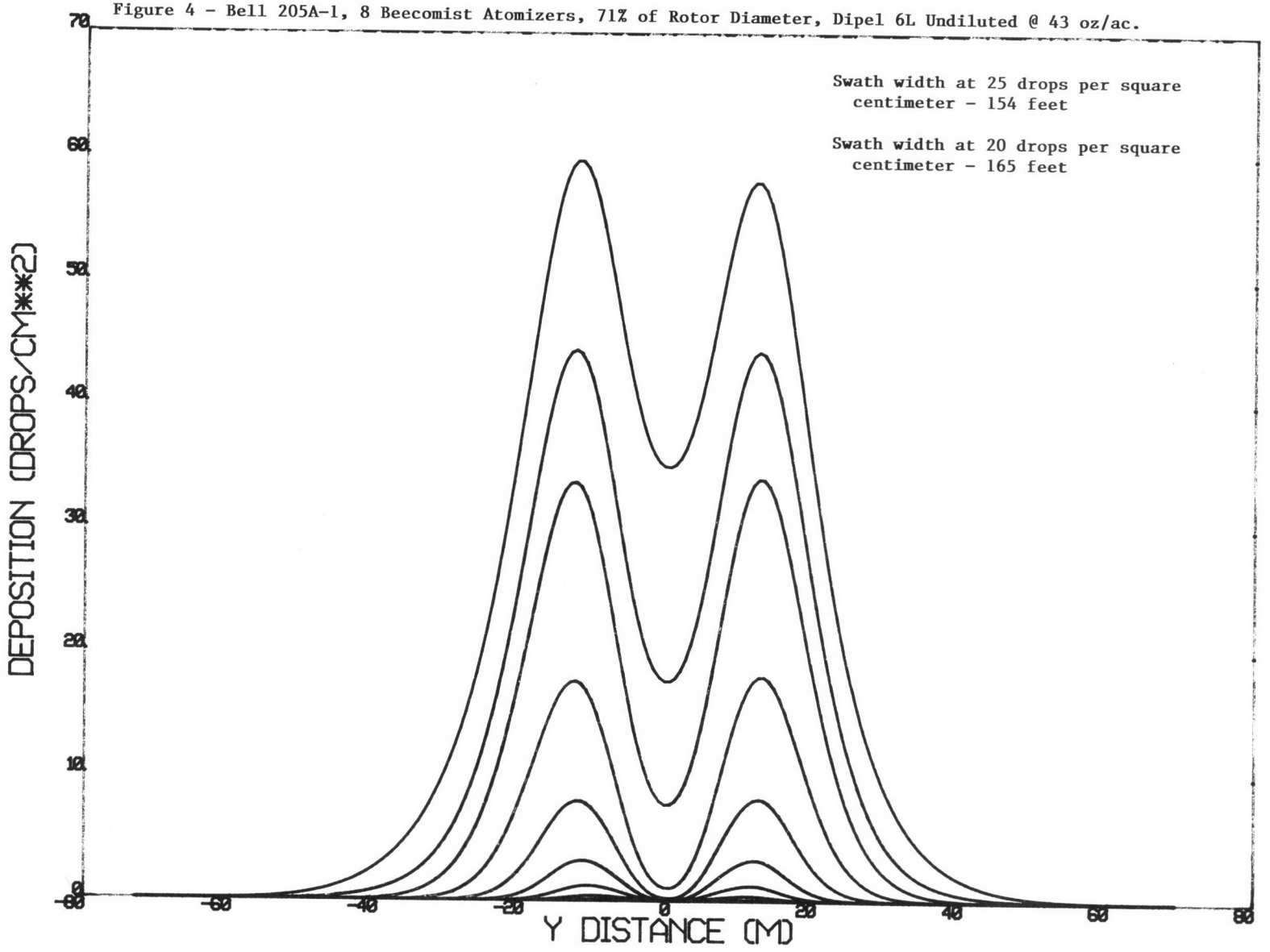

Figure 5 - UH1, 8 Beecomist Atomizers, 74% of Rotor Diameter, Dipel 6L Undiluted @ 43 oz/ac.

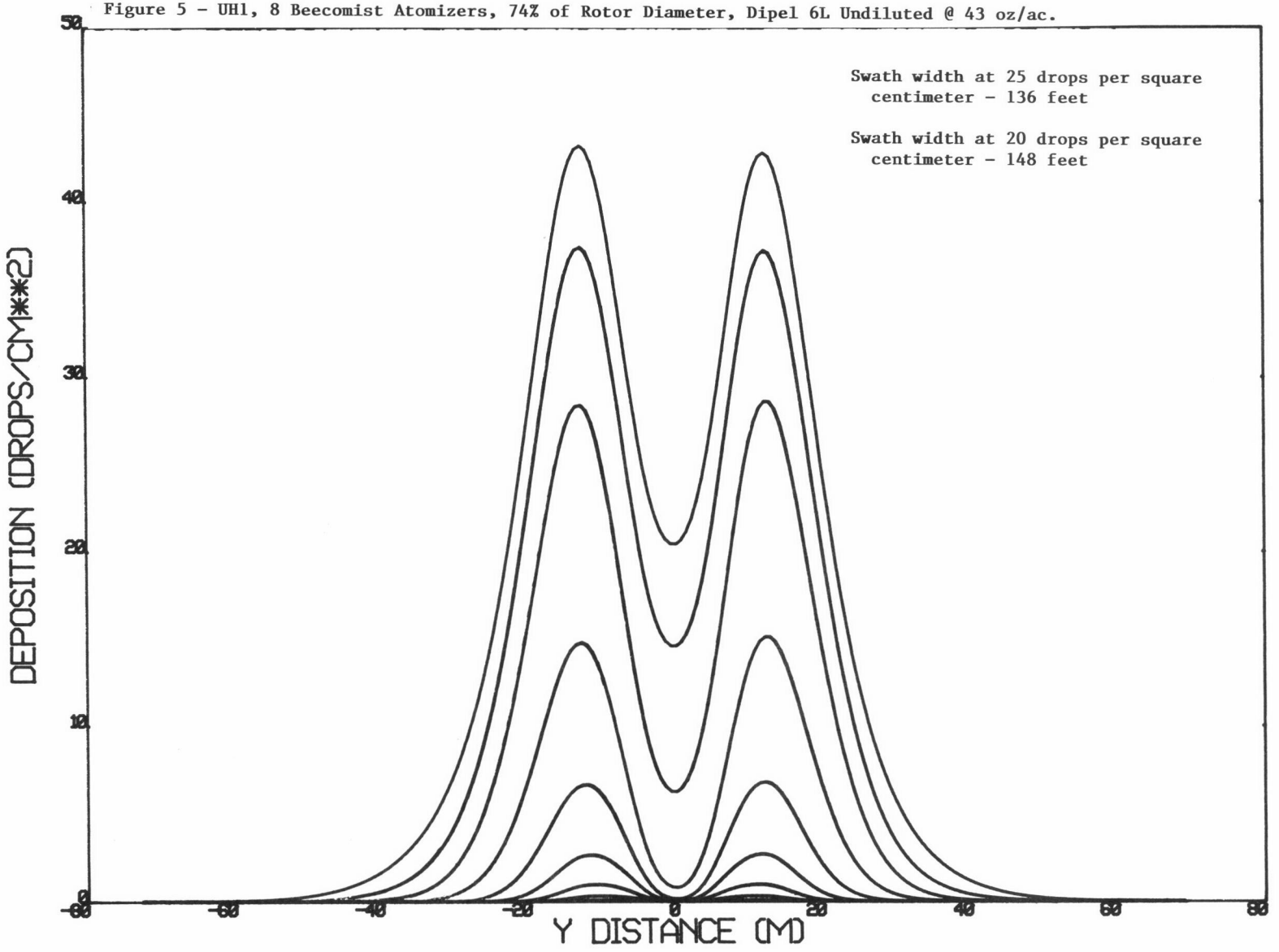

Figure 6 - UH1, 8 Beecomist Atomizers, 70% of Rotor Diameter, Dipel 6L Undiluted @ 43 oz/ac.

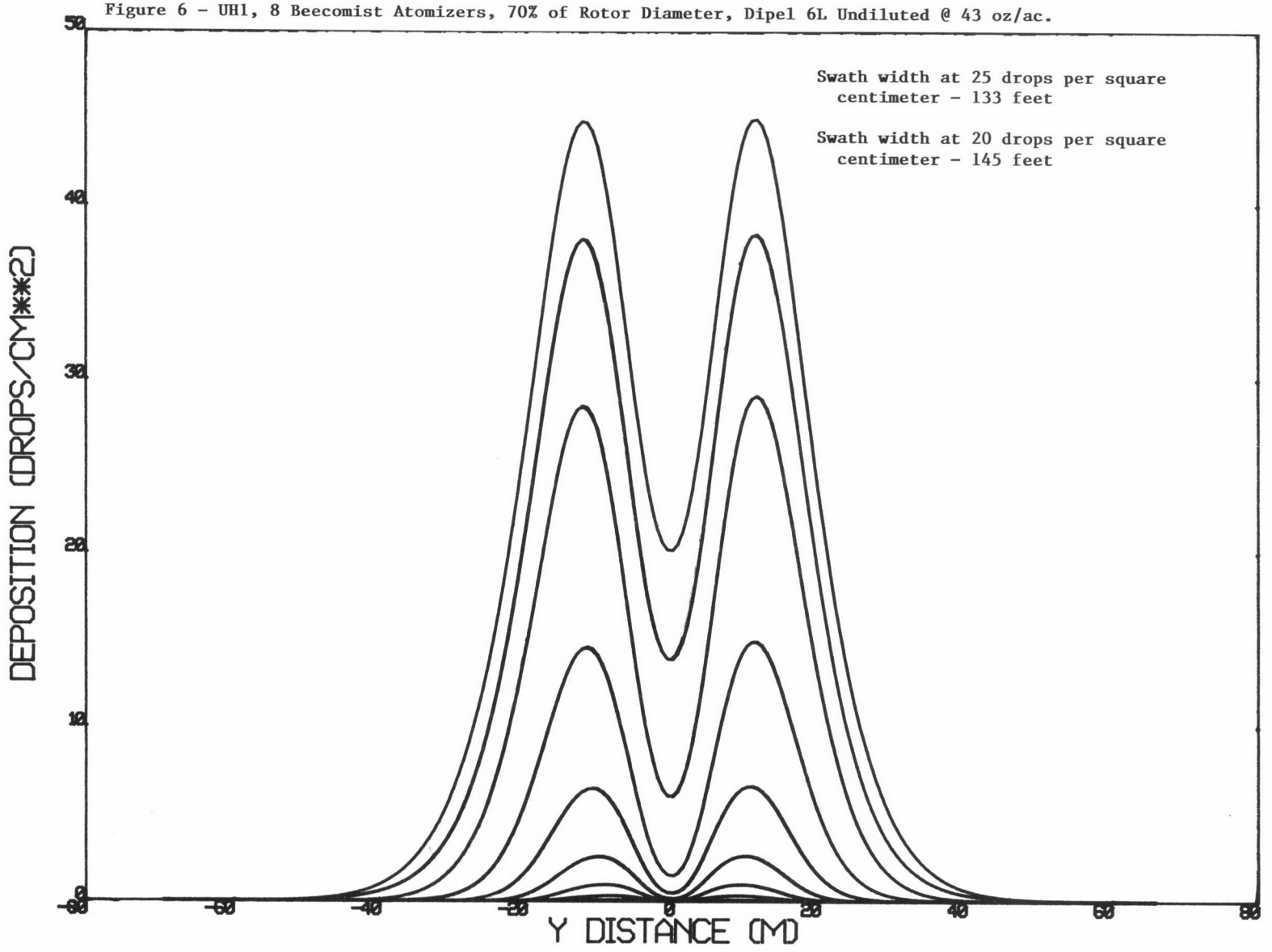

Figure 7 - Hiller 12E, 6 Beecomist Atomizers, 54% of Rotor Diameter, Dipel 6AF Undiluted @ 43 oz/ac.

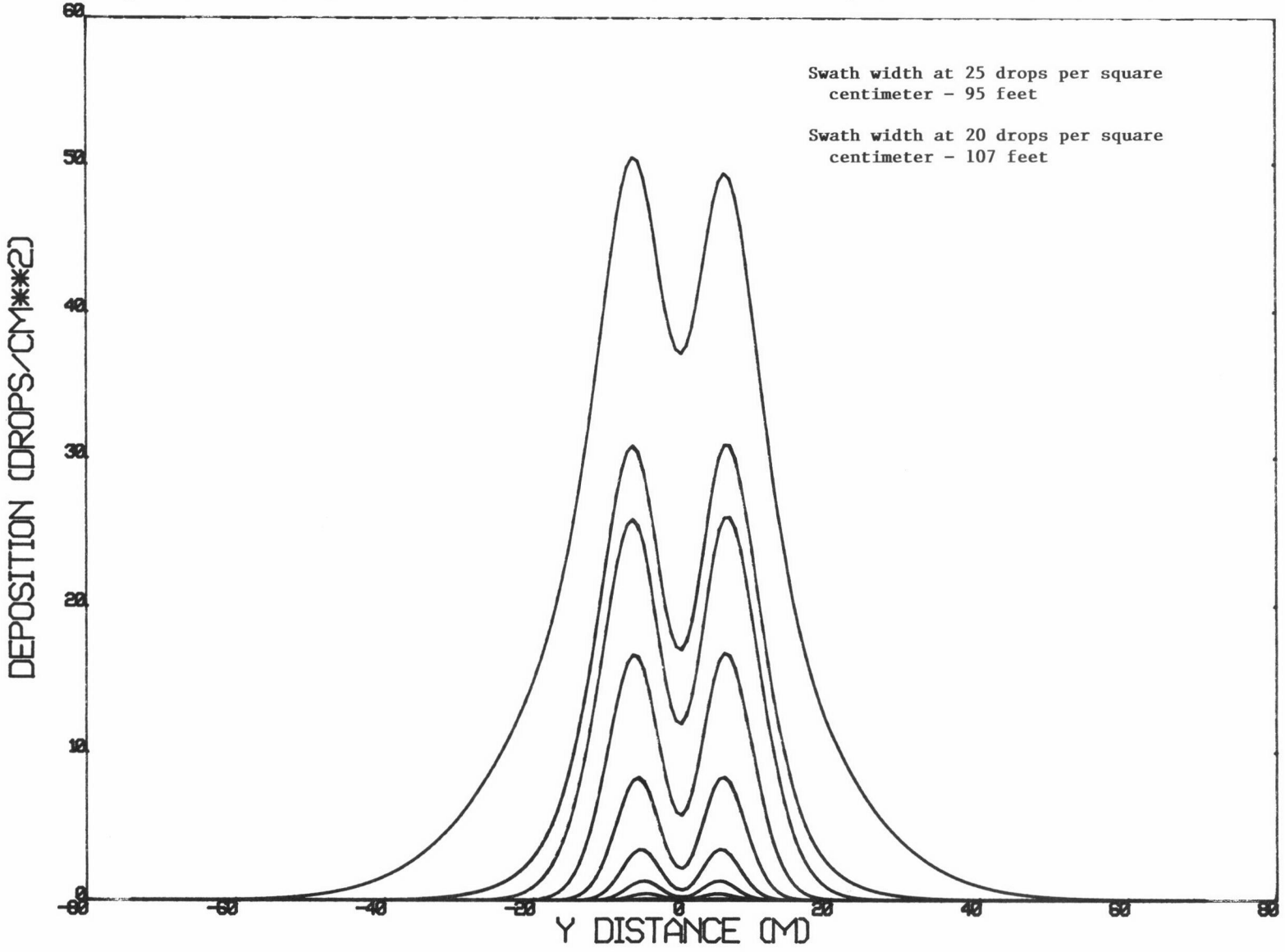

Figure 8 - Hiller 12E, 6 Beecomist Atomizers, 50% of Rotor Diameter, Dipel 6AF Undiluted @ 43 oz/ac.

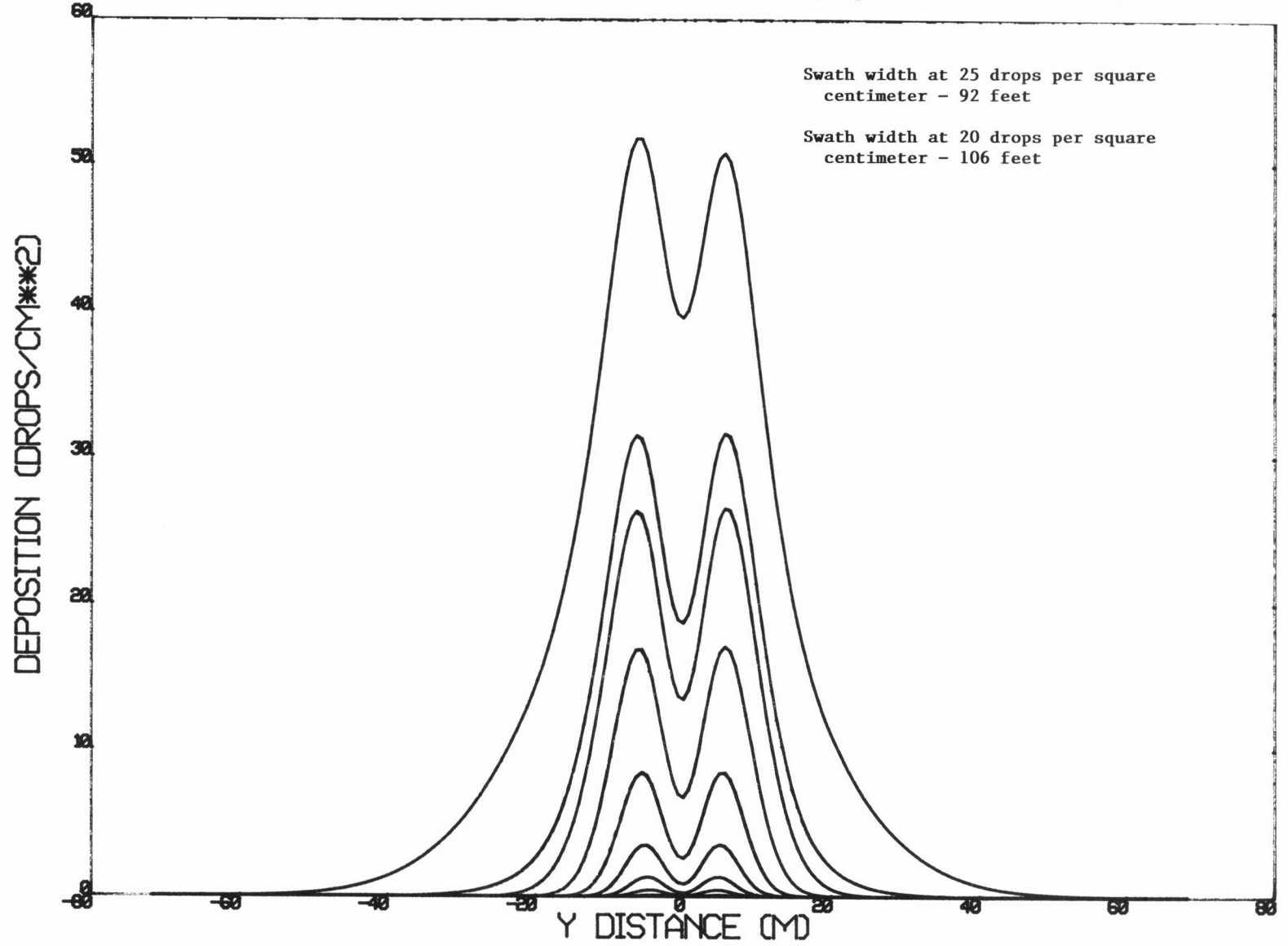

Figure 9 - Hiller 12E, 6 Beecomist Atomizers, 54% of Rotor Diameter, Thuricide 48LV Undiluted @ 43 oz/ac.

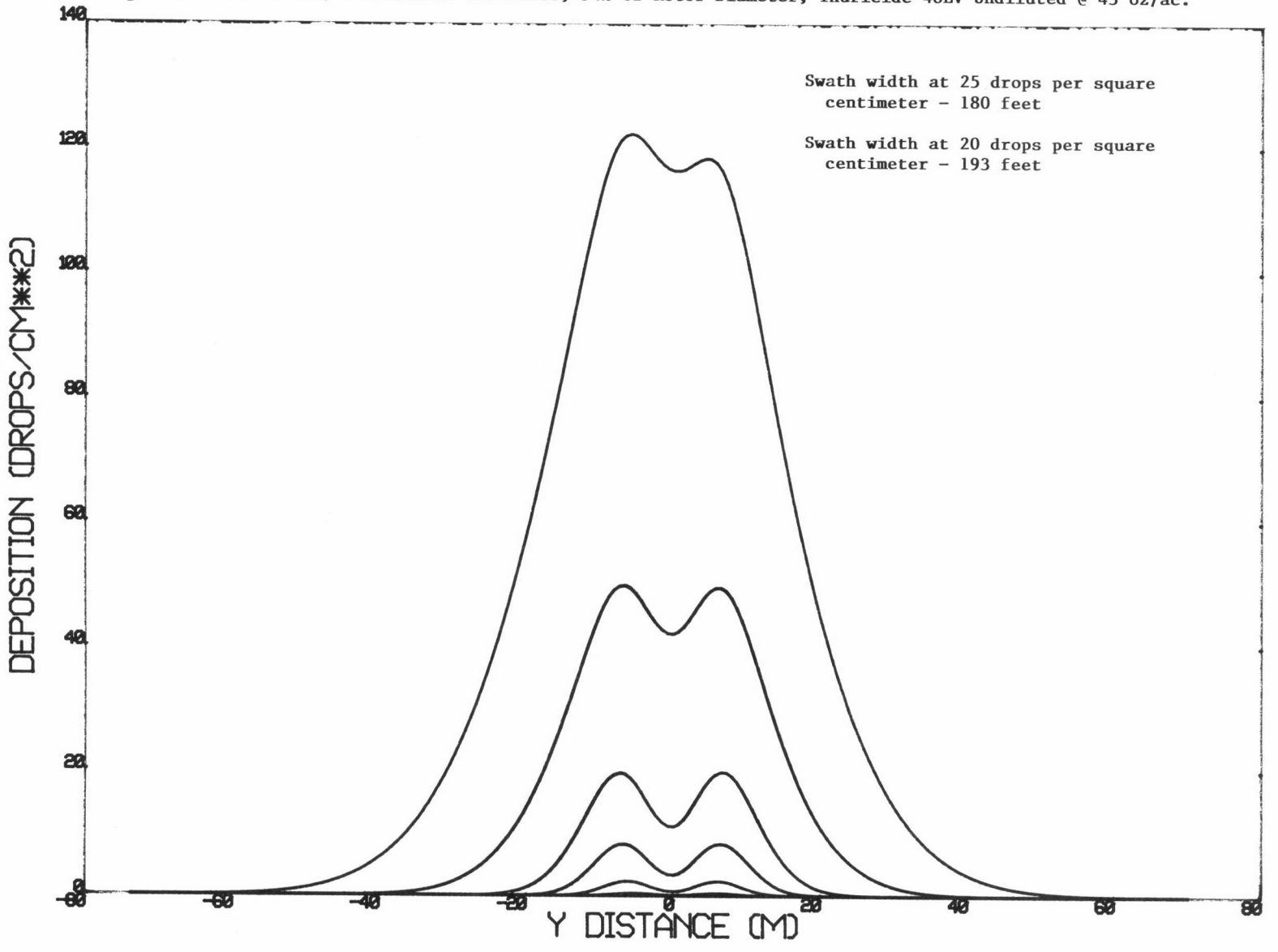

Figure 10 - Hiller 12E, 6 Beecomist Atomizers, 50% of Rotor Diameter, Thuricide 48LV Undiluted @ 43 oz/ac.

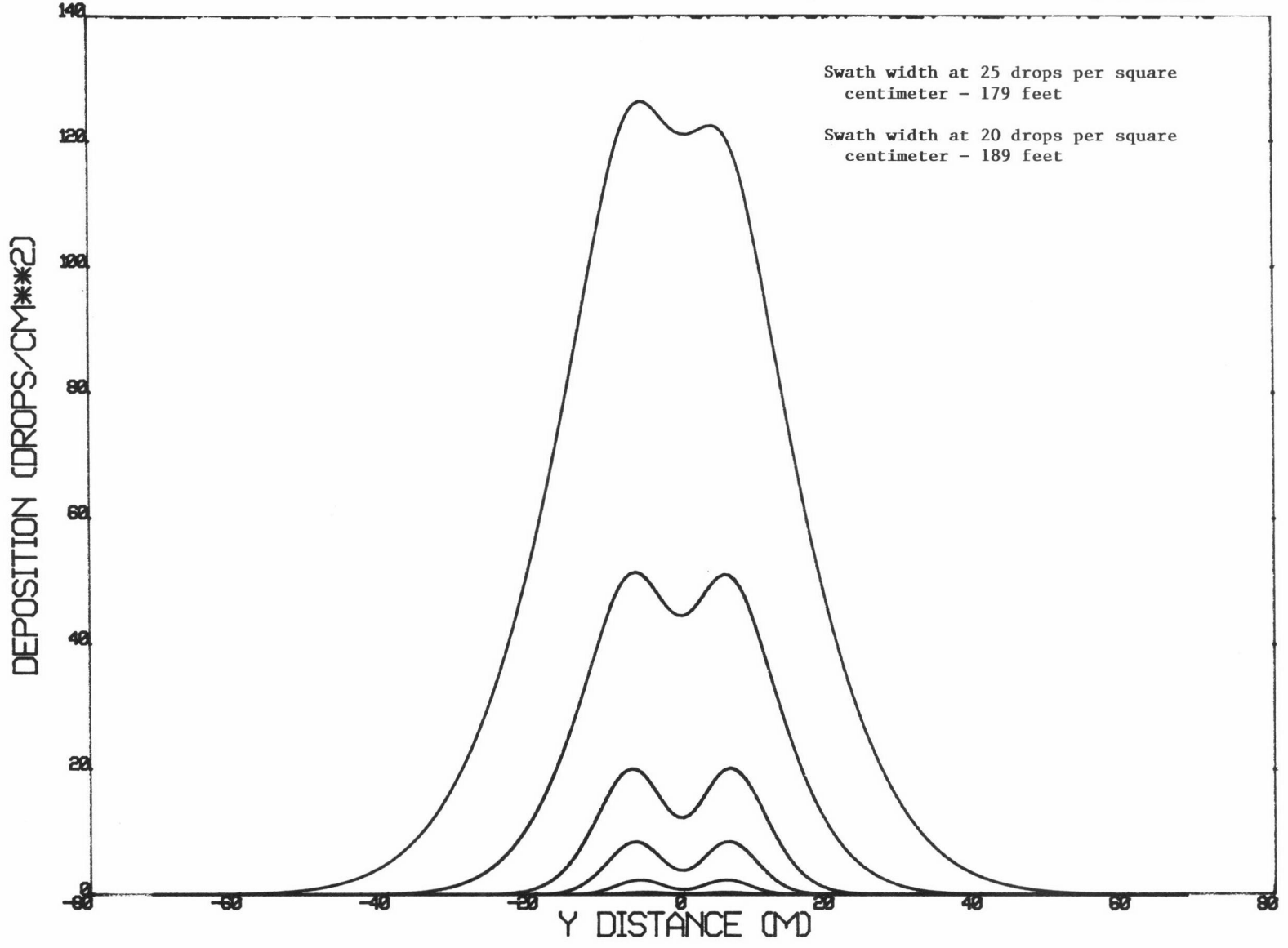

Figure 11 - Bell 212, 8 Beecomist Atomizers, 69% of Rotor Diameter, Thuricide 32LV Undiluted @ 64 oz/ac.

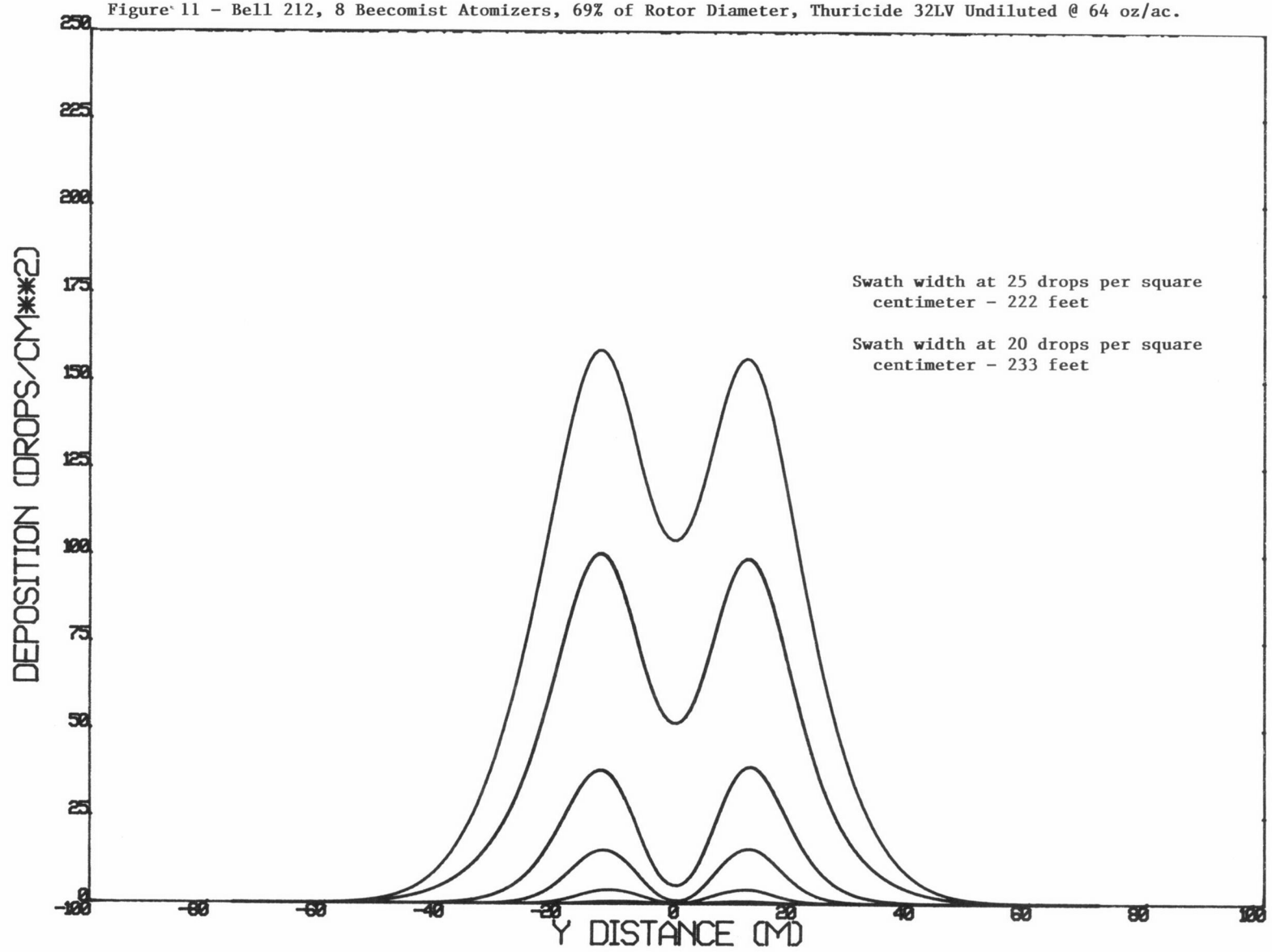

Figure 12 - Bell 212, 8 Beecomist Atomizers, 63% of Rotor Diameter, Thuricide 32LV Undiluted @ 64 oz/ac.

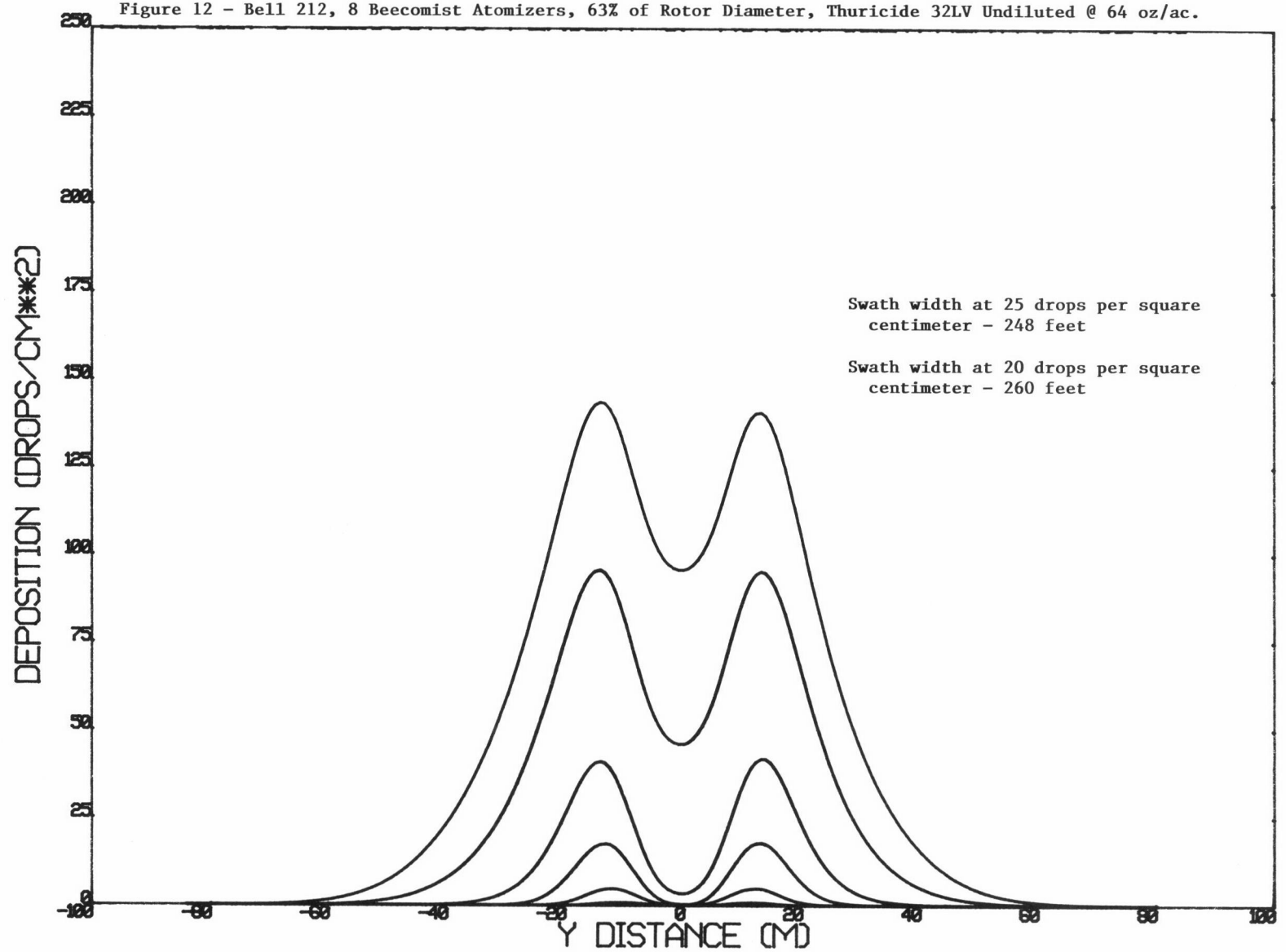

Figure 13 - Bell 212, 8 Beecomist Atomizers, 56% of Rotor Diameter, Thuricide 32LV Undiluted @ 64 oz/ac.

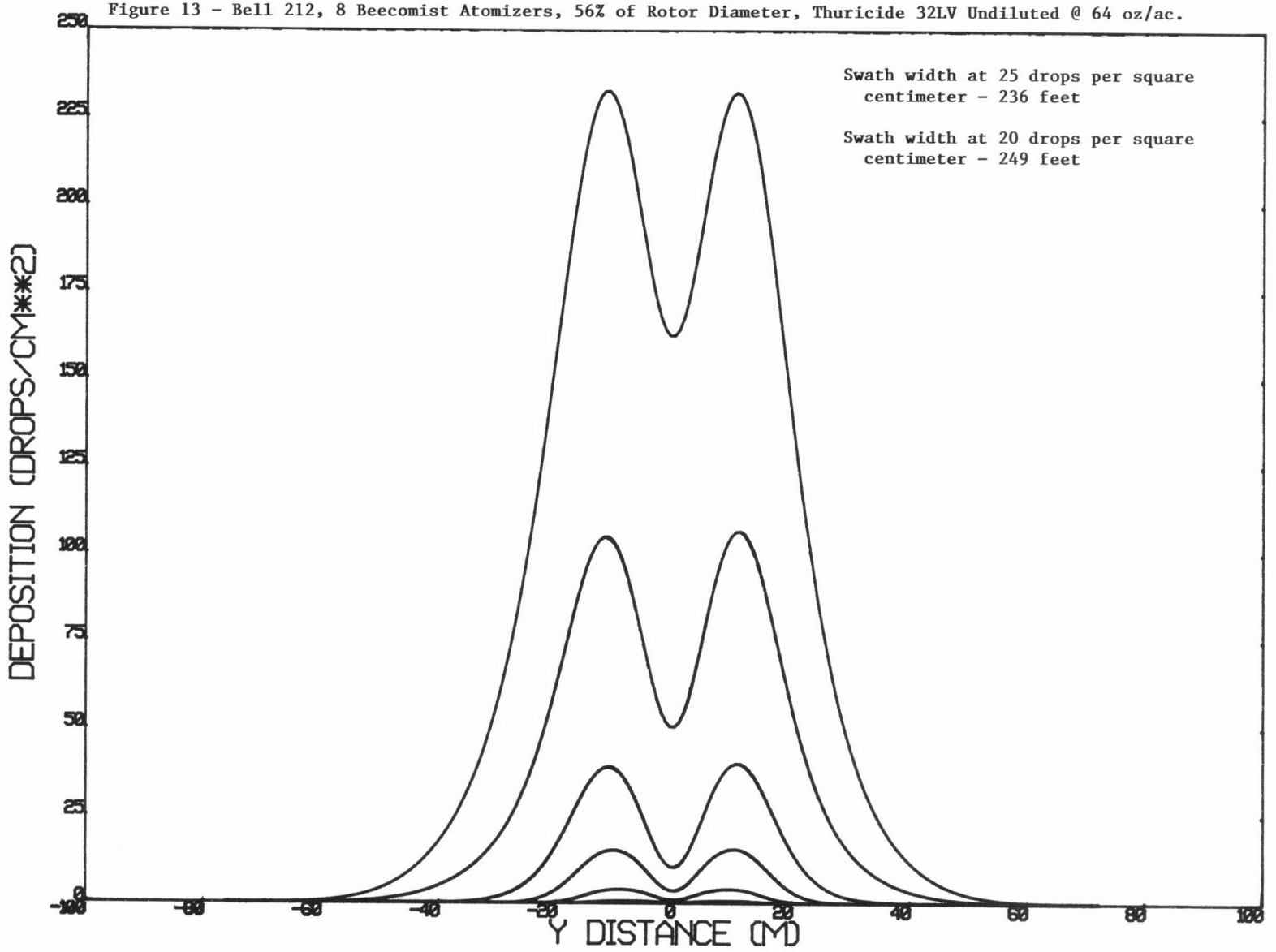

Figure 14 - Bell 205A-1, 8 Beecomist Atomizers, 72% of Rotor Diameter, Thuricide 32LV Undiluted @ 64 oz/ac.

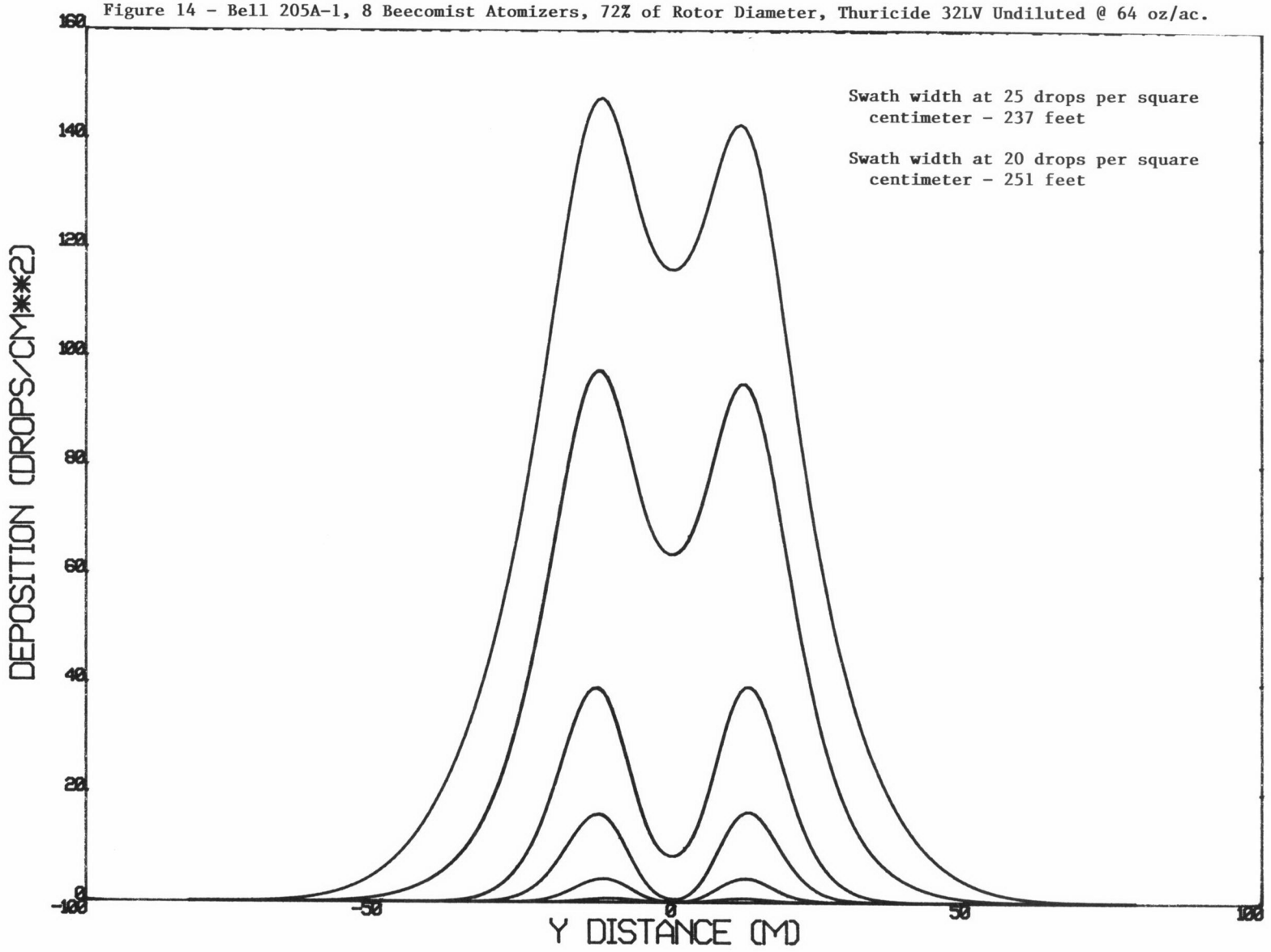

Figure 15 - Bell 205A-1, 8 Beecomist Atomizers, 63% of Rotor Diameter, Thuricide 32LV Undiluted @ 64 oz/ac.

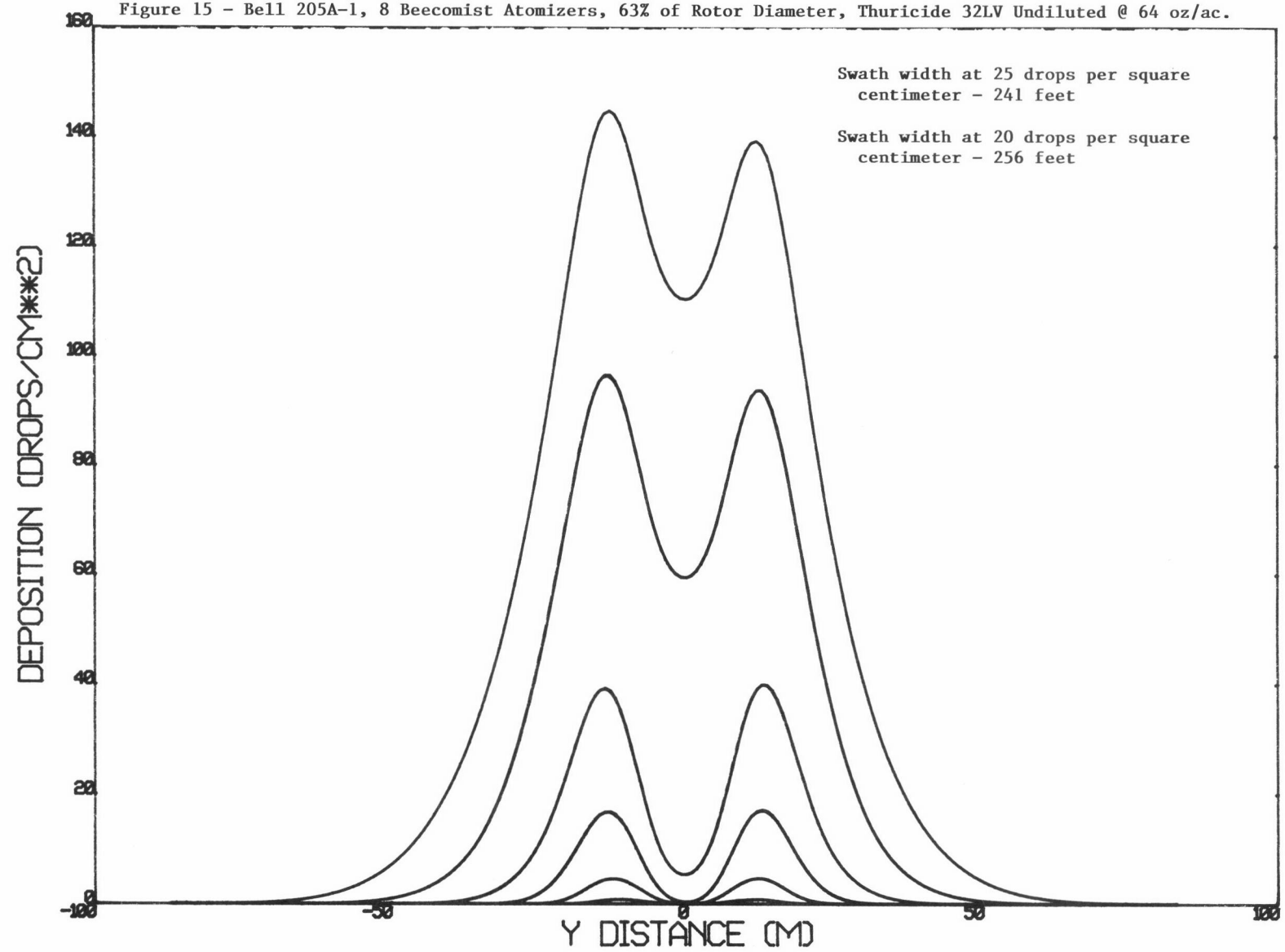

Figure 16 - Lama, 6 Beecomist Atomizers, 67% of Rotor Diameter, Thuricide 32LV Undiluted @ 64 oz/ac.

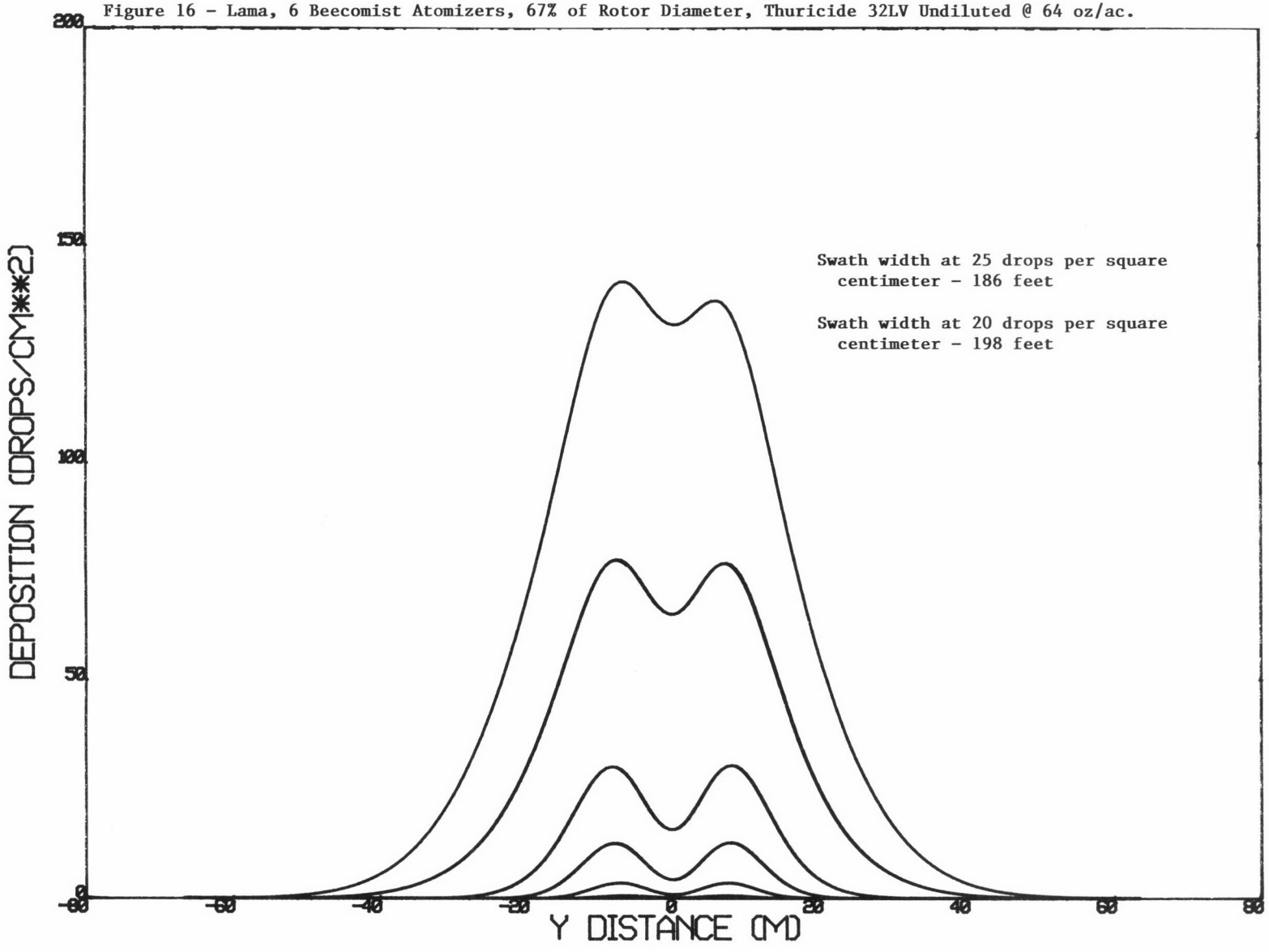

Figure 17 - Lama, 4 Beecomist Atomizers, 71% of Rotor Diameter, Thuricide 32LV Undiluted @ 64 oz/ac.

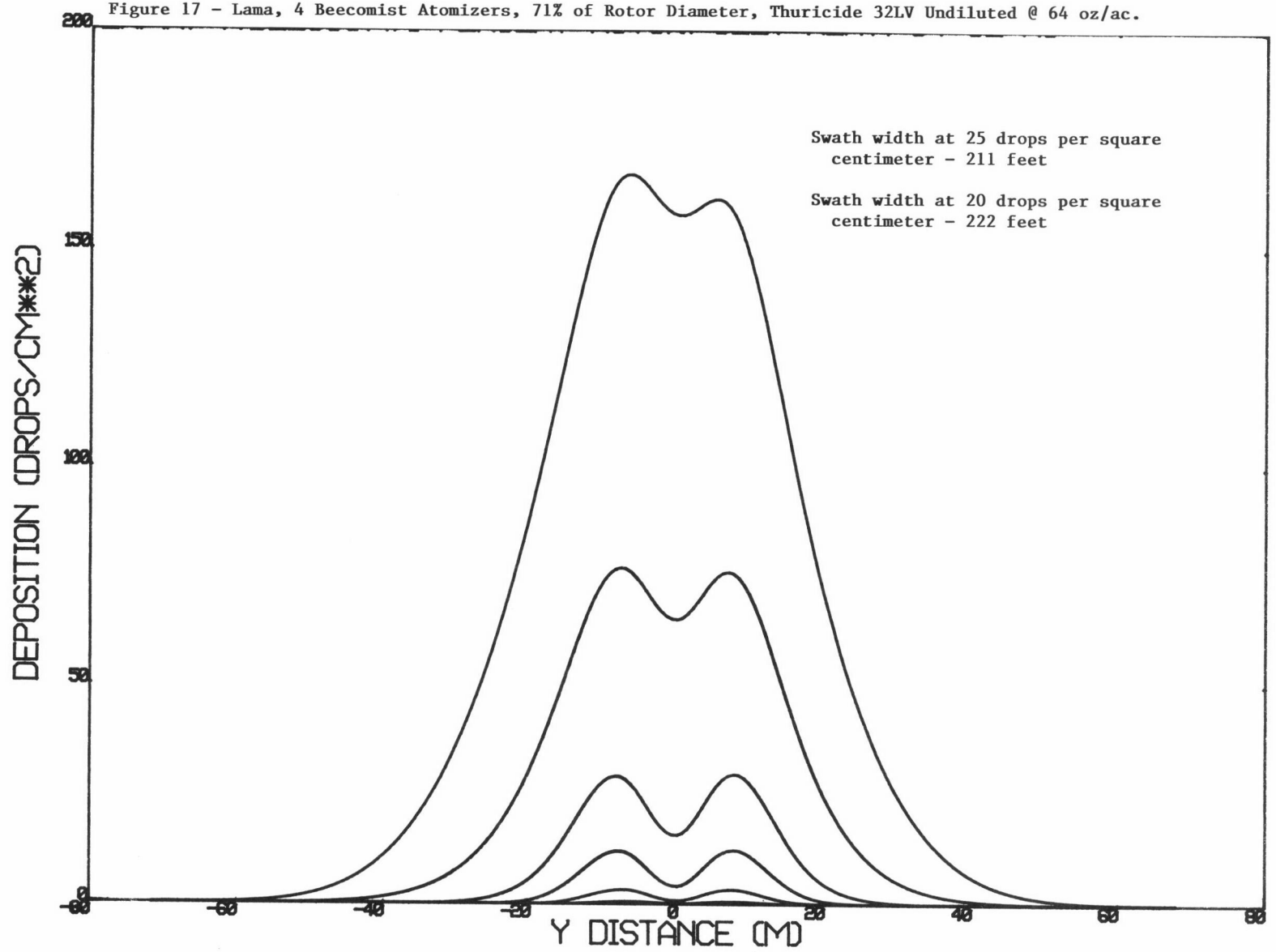

Figure 18 - Lama, 4 Beecomist Atomizers, 62% of Rotor Diameter, Thuricide 32LV Undiluted @ 64 oz/ac.